

Report for 2002TN5B: Water Quality monitoring in two 303(d)-listed East Tennessee streams

- Conference Proceedings:
 - Harden C, R Milam, 2002, Partnering for student stream monitoring yields more than data, in Proceedings from the Thirteenth Tennessee Water Resources Symposium, April 9-11, 2003, Tennessee Section of the American Water Resources Association pp. 3C-10 3C-14, (also presented orally).
 - Jolly, B A, 2002, Testing the Chemical Perturbation Index in a mixed land-use Knoxville stream, in Proceedings from the Thirteenth Tennessee Water Resources Symposium, April 9-11, 2003, Tennessee Section of the American Water Resources Association, pp. 2B-2 2B-7, (also presented orally).
- Other Publications:
 - Heaton A, A Ridenour, R Vananda, 2003, A year-long study of water quality in Third Creek. Presentation and poster at Undergraduate Research Fair, University of Tennessee, April 3-4, 2003.
 - Lawson, J, 2003, Know the creeks to understand the river, Story with photo in the Knoxville News-Sentinel Monday, May 5, 2003, page B-8.
 - Other products include (i) the poster from undergraduate fair, (ii) student reports and presentations from Geography 436 research groups, (iii) the M.S. thesis by B. A. Jolly (expected Dec. 2003 or early 2004), and (iv) suspended sediment data (mg/L) from Stock Creek from fall 2002.

Report Follows:

In 2000, the Tennessee Department of Environment and Conservation reported that more than 6,500 miles of streams and rivers surveyed did not meet water quality standards. An associated and especially critical problem is that of the difficulty and cost of obtaining sufficient information about the quality of the state's streams and rivers to identify and remediate water quality. The same TDEC report noted that only 40 % (36,000 of 60,000 total river and stream miles in the state) have not been recently assessed. Monitoring is labor-intensive, and hence expensive, so water quality data are very scarce for Tennessee streams. Third Creek, the primary stream chosen for study in this project, is classified as impaired due to pathogens, nutrients, siltation, and habitat alterations.

The objectives of this research are:

- (a) To develop a one-year record of water quality for Third Creek and also to monitor water quality in an impaired Blount County tributary of the Little River.
- (b) To analyze the data collected during this year and also to compile and analyze data previously acquired by other entities.
- (c) To examine and compare sampling methods and sampling strategies, especially to test the Chemical Perturbation Index (CPI).
- (e) To involve undergraduate and graduate students at the University of Tennessee in stream monitoring

This research was also undertaken to extend understanding about sampling methods and strategies. One component of the project compared methods of sampling for suspended sediment. Two other areas of research emphasis, relates to sampling strategies and methods were:

- (1) To test the Chemical Perturbation Index (CPI) to determine whether it is a useful indicator for these watersheds, and whether groups of students (essentially the general public) can achieve replicable results using this index.
- (2) To have a group of 35 to 40 citizens (UT students) involved in the water quality monitoring offers an opportunity to assess the strengths and weaknesses of citizen monitoring and to propose ways of improving the quality of data obtained by such groups.

(7) Methods and Accomplishments:

The major accomplishment of this project was completion of a year of water quality monitoring on Third Creek, in Knoxville. Monitoring occurred in two phases. In the first, between February and April 2002, 37 UT students enrolled in Geography 436 (Water Resources) monitored water quality at 10 sites on Third Creek and the East Fork of Third Creek. Students sampled weekly, and did their own lab analyses using LaMotte kits for nitrate-N and phosphate, ammonia, calcium hardness, chromium, copper, and dissolved oxygen. They measured pH using meters in the lab, determined temperature at the stream with thermometers, and used "Coliscan" kits to grow and count colonies of *E. Coli*. Turbidity and conductivity were measured on some samples in the lab using meters. Students measured the width and depth of the wetted channel and estimated flow (float method) in the field. They also completed a visual assessment of the study reach using the NRCS protocol, and a windshield survey of the contributing watershed.

In the second phase, after the Water Resources course ended, the number of sites was reduced to three (Sullivan and Western, Webb Lane, and the Third Creek Greenway at Painter Ave.). Summer sampling (biweekly) and lab work were done by one undergraduate student, Nicole Grant, a microbiology major who had taken the Water Resources course in the spring. During the fall, two sites (Sullivan/Western and Greenway/Painter) continued to be sampled biweekly by two teams of two undergraduate students Allison Ridenour, Renee Vananda, Will Wise, and Leslie Currah. Ashley Heaton joined the team in January 2003 after Wise and Currah graduated. All of these students had taken Geog. 436. Students were paid hourly

wages for sampling and lab work until the spring semester of 2003, when Heaton, Ridenour and Vananda elected to do the work for course credit (Geography 494 Research Experience) rather than be paid.

Graduate student B. Alan Jolly collected water samples from Third Creek (also First and Goose Creeks) and analyzed them for conductivity, alkalinity, and hardness to develop a database with which to test the utility of the Chemical Perturbation Index in urban streams. He also compiled information on previous water quality data for Third Creek. The graduate student (Young) who had intended to monitor suspended sediment in Stock Creek installed a rising stage sampler at Martin Mill Pike and began to develop a database (processed 22 suspended sediment samples), but then changed thesis topics and did not continue with the Stock Creek project.

Monitoring of Third Creek by Geography students was done as a collaboration between the UT class, the Water Resources Research Center, and the City of Knoxville. Roger Milam, from the city's Stormwater Engineering Department spoke to the class and attended the class meetings during which students presented their results.

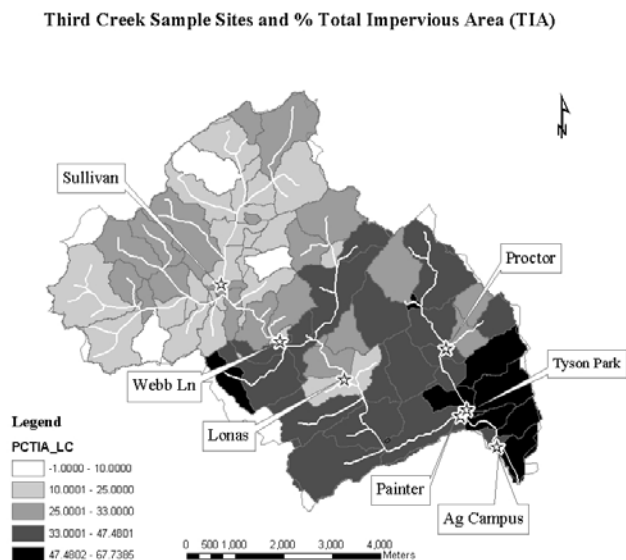
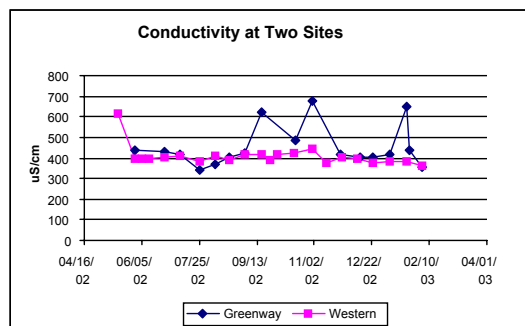


Figure 1

(Figure from B.A. Jolly)

(8) Principal Findings and Significance:

a) Third Creek water chemistry:



- Conductivity and hardness tend to increase downstream (between Western Ave and Painter Ave.).

- Nitrate-N (ppm) was almost always present, except at the upstream (Sullivan and Western) site.
- Phosphate (ppm) was almost always absent above the petroleum tank farm, but almost always present below the tank farms and on the East Fork. One grab sample from Third Creek below Middlebrook Pike, and two from the East Fork near Western Ave. had elevated phosphate levels of 4 ppm.

Harden met with TDEC and City personnel in the spring of 2002 to present preliminary results. A very important contribution of the Geography 436 students was their weekly presence at streamside at 10 locations. They noted unusual conditions and odors as well as changes over time in riparian and channel environments. One group, sampling Third Creek immediately downstream from Middlebrook Pike, reported a petroleum odor throughout the term. Just upstream, at Lonas Rd., students exploring a small tributary found what appeared to be a spring with an oily sheen and a dead turtle. These field observations helped the City to target a petroleum leakage problem, and led TDEC to test for (and find) hydrocarbons and work with the responsible parties toward better monitoring and mitigation. On other occasions, students telephoned the City's water quality hotline to report water quality problems they encountered in the field.

b) Bacteria:

E. Coli counts varied from 0 to 3000 per 100 mL. We ran 17 Coliscan tests for the upstream site (Sullivan and Western Ave.), of which seven had no *E. Coli*, and 10 had concentrations ranging from 100 to 1000 per 100 mL. At the Painter Ave. site (at the Third Creek Greenway bridge), 7 of 14 tests showed no *E. Coli*. The highest *E. Coli* counts came from the East Fork of Third Creek, at Western and Tennessee Ave and at Western Ave. and the railroad (up to 3000 per 100 mL). Although the data do not comprise a full time-series, they show the recurring but variable problem of bacteriological contamination, even in the upstream sector of the creek.

c) CPI (Chemical Perturbation Index):

Preliminary results showed that conductivity varied predictably with the ratio of alkalinity to hardness in Third Creek, so Jolly was encouraged to continue to develop his database to test the CPI on Knoxville streams. He extended his database to include sites on Goose and First Creeks, as well as Third Creek, and he is on schedule to complete his thesis in late 2003 or early 2004.

d) Sediment sampling methods:

In a limited comparison of single-stage, grab, and depth-integrating (DI) sampling methods, single-stage samplers performed poorly in flows that moved woody debris. In one comparative test of grab versus DI, the suspended sediment concentration measured with DI was twice that of the grab sample.

e) Student involvement:

Data collected during spring 2002 by Water Resources students are quite valuable for indicating presence or absence of water quality constituents. Some of the actual values obtained are questionable. We have most confidence in temperature readings and values obtained for Ca hardness and alkalinity. After the initial training, much of the sampling and lab analyses by student teams was done with only minimal supervision—the emphasis on monitoring numerous sites combined with the difficulty of fitting in this extra out-of-class assignment with other classes and work schedules meant that students did their sampling and lab work at various hours during the week. With very limited staff resources, field and lab safety necessarily had highest priority and data quality control received less attention, especially in spring

2002. Data from summer 2002 through Feb. 2003 are more reliable because they were obtained by a small number of students who were better trained, more responsible, and more closely supervised.

Student involvement had outstanding educational benefits. In written evaluations at the end of the term, students unanimously indicated that they would be more likely to participate in a volunteer citizen monitoring effort or a watershed alliance. They commented that they now noticed and thought about streams they crossed daily. Attendance in the Water Resources class was excellent, and the Third Creek sampling project appeared to add meaning and engagement to the student experience. One of the undergraduate students, Ashley Heaton competed for and was awarded a Summer Research Fellowship in Watershed Studies at the College of William and Mary. She participated in the 8-week program in the summer of 2003. Another undergraduate, Susanna Sutherland, is now working toward a Master's degree in Environmental Sciences at UT (gathering primary data from Ellejoy Creek). Alan Jolly, the graduate student involved with this project is completing a water quality modeling internship this semester with TVA and has accepted a water quality modeling research appointment with the UT College of Agricultural Sciences and Natural Resources.

(9) Future Research and Funding:

- (i) Contract with TDEC (Tennessee Department of Environment and Conservation) for water quality water quality sampling of 16 streams that drain to Fort Loudoun Lake (\$9554 plus \$9890 match), Fall 2003.
- (ii) Proposal "A watershed classification system for headwater contributing areas of the Southern Appalachian region" requesting \$636,214 was submitted by Harden, Robinson, Etnier, and Shaw to EPA for study of Little River Watershed (not successful on first attempt).
- (iii) Future research plans include involving undergraduate students in an assessment of the channel status of Beaver Creek (north Knoxville) in spring 2004, and ongoing research investigating sediment movement.